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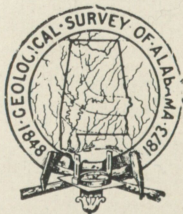
WALTER B. JONES, STATE GEOLOGIST (ON LEAVE)

BULLETIN 54

**GEOLOGY OF THE ALABAMA TIN
BELT**

BY

FRANK R. HUNTER



UNIVERSITY, ALABAMA

1944

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LETTER OF TRANSMITTAL

University, Alabama

May 31, 1944

Honorable John C. Sparks,
Governor of Alabama,
Montgomery, Alabama.

Sir:

I have the honor to transmit herewith the manuscript of a report on "Geology of the Alabama Tin Belt", by Frank R. Hunter. It is requested that this be printed as Bulletin 54 of the Geological Survey of Alabama.

Respectfully,

STEWART J. LLOYD,

Asst. State Geologist

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Geology of the Alabama Tin Belt¹

By Frank R. Hunter

INTRODUCTION

Scope of Work

This work represents the results of an investigation of the distribution, geologic mode of occurrence, origin, and possible utilization of the tin deposits of Coosa County, Alabama. The field studies were carried out during the summer of 1942. Thirteen weeks in all were spent in the district. All known lode deposits were mapped and studied in detail, and several new ones were discovered in the course of areal geologic mapping. The base for geologic mapping was prepared from aerial photographs with control points from the Wetumpka Quadrangle of the United States Geological Survey, 1889. Observations were carried to points outside the district to establish relationships between the local rocks and those of the surrounding region.

Representative specimens taken systematically across the Pinckneyville "granite" and the tin-bearing areas were sent to Dr. N. B. Keevil of the University of Toronto for geothermal studies.

Acknowledgments

The writer wishes to express his gratitude to the many who have assisted in the investigation. The State of Alabama provided funds for the field work and the preparation of thin sections of rocks collected for laboratory analyses. Dr. S. J. Lloyd, Assistant State Geologist, Alabama, suggested and authorized the work and gave valuable assistance. Mr. David L. DeJarnette, curator of the Alabama Museum of Natural History, also gave aid as did staff members of the Geological Survey.

¹This paper is a portion of a dissertation presented to the Faculty of Cornell University in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Aerial photographs prepared for the Agricultural Adjustment Administration were made available through Mr. Arant, Coosa County Agent. A spectrographic analysis was made on one of the rare minerals by Mr. Creitz in the laboratory of the Bureau of Mines, Tuscaloosa, Alabama. Geothermal data were contributed by Dr. N. B. Keevil of the University of Toronto Department of Physics. Information on the prospecting and mining development was given by Mr. C. A. Dean of Alexander City, Alabama, president of the Coosa Cassiterite Corporation. Mr. McKinley Hoyt served as field guide and helper.

Acknowledgments are due Dr. A. L. Anderson, who directed the research, Dr. C. M. Nevin, Dr. J. D. Burfoot, Jr., and Dr. Katherine V. W. Palmer; all members of the Cornell faculty who offered many valuable suggestions.

Previous Work

Previous work in the district is indicated by the limited bibliography that has accumulated. The publications resulting from previous work are listed below.

- 1880—Smith, E. A.—Field Notes—recorded the discovery of tin on the property of J. S. Bentley one and one-half miles west of Rockford; reported by Adams (1930, p. 89).
- 1883—Williams, A., Jr.—Min. Res. of U. S., U. S. Geological Survey, pp. 434-436. Description of Broken Arrow tin mine near Ashland, Clay County.
- 1884—Blake, W. P.—Tin-Min. Res. of U. S., U. S. Geological Survey, pp. 601-602. Described the Broken Arrow Mine.
- 1887—Day, D. T.—Min. Res. of U. S., U. S. Geological Survey, pp. 214. States that Henry J. Biddle found no tin at the Broken Arrow mine and that E. A. Smith had analyzed supposed tin ore and found no trace of tin.
- 1891—Phillips, W. B.—“The Lower Gold Belt of Alabama”, p. 28. Locality mentioned by Smith in 1880 was visited and the occurrence of tantalite as well as cassiterite noted.

- 1904—Graton, L. C.—“Tin in the U. S.”—Bull. 260, U. S. Geological Survey, p. 164. Listed the Bentley property and the Broken Arrow mine near Ashland.
- 1930—Adams, G. I.—“Gold Deposits of Alabama”. p. 89. Gave short summary of tin on the Bentley property and of the Broken Arrow “fiasco”.
- 1934—Ellsworth, E. W.—“Tin Deposits of Alabama”. Press Mem. U. S. Dept. of Int. Misc. paper 91, P. W. 20674. First and only detailed description of the tin occurrences, with map, samples, and analyses of the three known deposits. Concluded that the deposits “have slight if any commercial value”.
- 1939—Bowles, Edgar—“The Tin Deposits of Coosa County, Alabama”, Misc. Paper 124, Geological Survey of Alabama. Report of cursory examination, “grab” samples, and analyses of the ten known deposits.

Geography

Location

All the known tin deposits of Alabama are within a very narrow belt extending northeasterly from a few miles northeast of Rockford to a few miles southwest of Goodwater in eastern Coosa County. (See fig. 1.) This belt is about 15 miles long and 2 to 3 miles wide. Its center is approximately $32^{\circ}55'$ north latitude, and $86^{\circ}12'$ west longitude.

Routes of Approach

The region embracing the tin deposits is not easily accessible. Alabama State Highway No. 11, which extends north and south through Rockford, is the only paved road in the district. It lies, for the most part, to the west of Hatchet Creek, which parallels the western edge of the tin belt. It crosses Hatchet Creek and the tin belt in the very southern part of the district. This highway is the only one that crosses both the creek and the strip containing

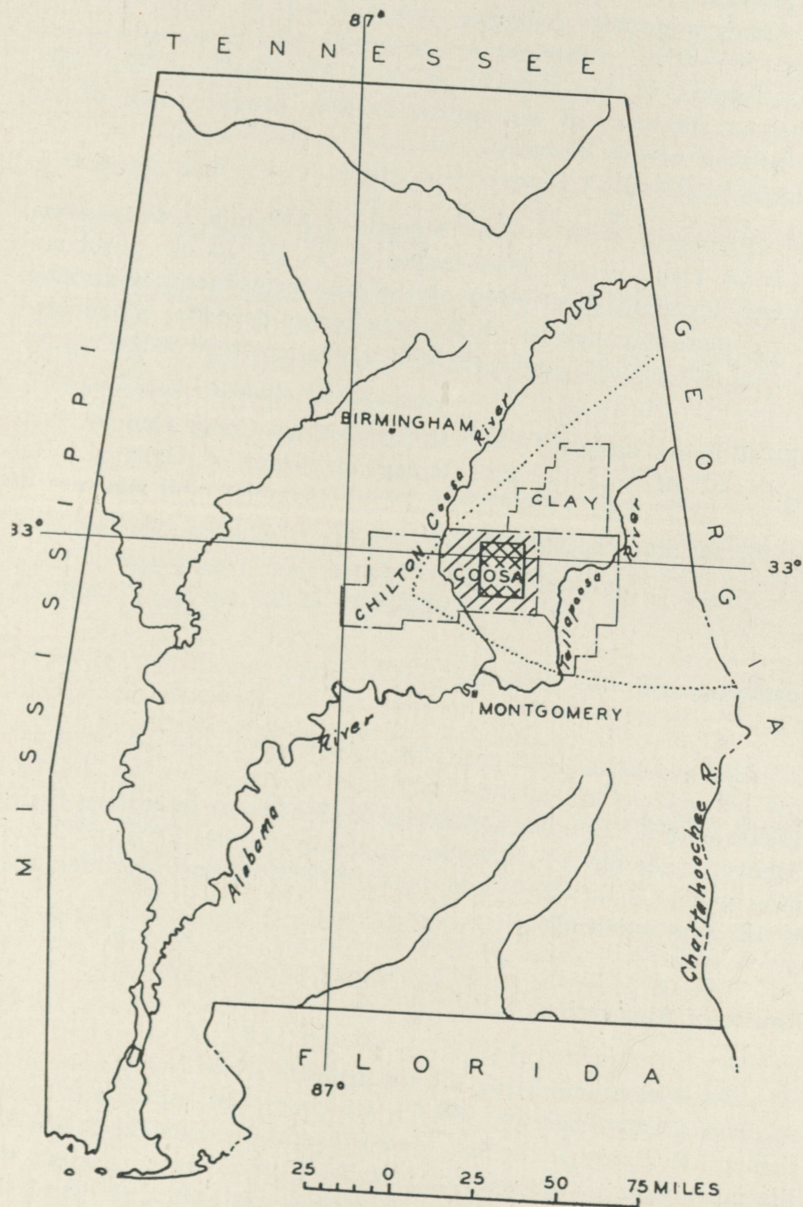


Figure 1. Index Map of Alabama showing Coosa County and area mapped on Plate I.

the tin deposits. A new State highway (No. 22) extending east and west through Rockford is under construction. Numerous clay roads traverse the area but many of the roads have reverted to trails. The only railroad is the main line of the Central of Georgia, which crosses the northeast corner of the county.

Surface Features

The district covers part of the Piedmont, lying between the Atlantic Coastal Plain and the Appalachian Mountains. Locally the Piedmont is known as the Ashland Plateau. This surface has been eroded into low, rolling, elongated hills which in the eastern part of the area have summits 500 to 600 feet, and, in the western part, 700 to 800 feet above sea level. These hills rise 200 to 300 feet above valley bottoms and are aligned in a northeasterly direction. Much of the drainage also shows a northeast alignment. The eastern part of Coosa County, including the tin belt, is drained by Hatchet Creek, a tributary of the Coosa River.

Climate, Weathering, and Vegetation

The area has a mild humid climate with an average annual rainfall of about 53 inches. Because of the local relief, the precipitation penetrates deeply into the ground, the water table lying about 25 feet below the surface. Consequently, rock decay extends to considerable depth and little fresh rock is found close to the surface.

The more rugged country is covered with timber and is sparsely inhabited. Farming in the eastern part of the county has been extensive in the past, but now most of the land is abandoned to brush and second growth timber. The foliage of the thick brush makes field work difficult during the summer season.

GEOLOGY

General Setting

Most of the area is underlain by schistose and gneissoid rocks of the pre-Cambrian Ashland series, which have been profusely invaded by quartz veins, pegmatites, and irregular granitic masses. The area also has a zone of highly altered rock that includes the tin

belt, which previous writers have designated as the Wedowee formation and to which they have assigned an age ranging from Cambrian to Carboniferous (Adams, 1926, p. 36). As the Wedowee locally may be merely a more intensely metamorphosed part of the Ashland, it is dropped as a separate formation.

The Ashland is bordered on the west by the Hillabee chlorite schist and on the east by the Pinckneyville granite, the first of which is presumed to be younger and the second known to be younger than the Ashland.

The rocks comprising the Ashland have been severely folded and faulted, but metamorphism has so masked the original bedding that the structural relations are imperfectly known. The schistosity and the structural trends are directed to the northeast.

Stratigraphy

Ashland Series

The Ashland series contains a variety of metasedimentary rocks, which are not sharply delineated, but show transitions from one to another. Those distinguished include muscovite schist, garnetiferous schist, phyllite, hornblende schist and gneiss. In places the schists are highly feldspathic and show a close resemblance to granitic rock. Feldspathic schists and quartz-diorite gneiss are also distinguished.

Muscovite Schist

Distribution and Character

The muscovite schist makes up the larger part of the Ashland series. It is particularly well represented in the western part of the district where it is not so feldspathic as it is closer to masses of the Pinckneyville granite. In some places, especially in the eastern part of the district, it shows transitions into phyllite and into garnetiferous mica schist.

Much of the schist is highly laminated and fissile, splitting readily into thin sheaves. Its color ranges from light to fairly dark gray, and the texture, from fine to medium-grained, both

color and texture depending on the kinds and amounts of minerals present. Most of the schist is composed predominantly of muscovite and quartz with minor amounts of biotite. There may also be more or less sillimanite, garnet, sericite, graphite, zircon, apatite magnetite, and locally feldspar, only some of which are recognizable without the microscope. The schist has a pearly luster on freshly exposed cleavage surfaces, but in places sillimanite and sericite have added a bluish sheen. As biotite increases in abundance, the pearly luster darkens.

Weathering has masked, but has not destroyed the schistose structure. The weathered rock is friable and more or less stained by limonitic oxides.

Mineral Relations

The schistose structure is prominently displayed in thin sections. Most of the mica has a parallel orientation and is more or less closely segregated into thin bands which alternate with those of quartz. Not all minerals, however, are precisely oriented. Some cut across the schistosity and have partly masked the foliation.

Muscovite appears to be the most abundant mineral in the schist. It shows considerable variation in grain size and in its relations to other minerals. Some rather small grains are intimately associated with the quartz grains and show imperfect orientation. These as well as the associated quartz commonly are penetrated by, and appear as remnant inclusions in, large grains of muscovite and other minerals. The larger muscovite grains on the other hand are all in parallel orientation and cut indiscriminately through the smaller quartz and muscovite grains, engulfing many of them as corroded inclusions. There are also other muscovite grains of small size which, with sericite and commonly, too, with sillimanite, penetrate the large grains of muscovite.

The never-abundant biotite has much the same relations as the small first-mentioned grains of muscovite. Some of it is scattered through the quartz and some is held as corroded remnants in the larger grains of muscovite.

The quartz, which is second to muscovite in abundance, forms granular aggregates between the large grains of muscovite and

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color and texture depending on the kinds and amounts of minerals present. Most of the schist is composed predominantly of muscovite and quartz with minor amounts of biotite. There may also be more or less sillimanite, garnet, sericite, graphite, zircon, apatite magnetite, and locally feldspar, only some of which are recognizable without the microscope. The schist has a pearly luster on freshly exposed cleavage surfaces, but in places sillimanite and sericite have added a bluish sheen. As biotite increases in abundance, the pearly luster darkens.

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The never-abundant biotite has much the same relations as the small first-mentioned grains of muscovite. Some of it is scattered through the quartz and some is held as corroded remnants in the larger grains of muscovite.

The quartz, which is second to muscovite in abundance, forms granular aggregates between the large grains of muscovite and

small, rounded inclusions in the muscovite. There is also a more coarsely crystalline quartz with an entirely different habit. This quartz has uneven lobate borders and cuts and penetrates the micas and most of the other minerals and also holds them as irregular remnants. Some of this quartz is in seams which are directed along the schistosity.

Sillimanite may be present as scattered needles in the quartz or abundantly with sericite as felted aggregates that extend irregularly through the other minerals. In some places the sillimanite may comprise 30 to 40 per cent of the rock. Where it is not so abundant the needles lie along contacts between, or in fractures within, quartz grains, but where it is more abundant the closely packed needles penetrate deeply into the muscovite and quartz.

The graphite is more abundant in muscovite schist that contains notable amounts of sillimanite and sericite than in that which does not. It is the flake variety and appears as laths in thin section, which are embedded in and across grains of muscovite, quartz, and sericite. Much of it seems to be rather closely associated with the sericite and follows the sillimanite-sericite veinlets in the muscovite and quartz.

Garnet is noticeable only in schist that contains appreciable amounts of biotite. The crystals are no larger than the biotite grains but are commonly filled with remnant inclusions of muscovite, biotite, and quartz, and surrounded by small grains of muscovite.

The feldspar, a sodic plagioclase, has been observed only where the schist is near masses of granitoid rock. The feldspar generally contains remnants of the micas and the granular quartz, but like the other minerals it is cut and embayed by seams and grains of lobate quartz.

Zircon, magnetite, and apatite are scattered as small crystals through the schist, particularly along cleavages and grain boundaries, but crystals also project into the neighboring minerals.

Paragenesis

The relationships indicate clearly that the minerals were not formed all at the same time, but that some are earlier and have

been replaced by others. The sequence is fairly well defined.

Much of the earlier small quartz and muscovite has been widely replaced by biotite and larger muscovite, and these locally by feldspar, and then all by large grains of lobate quartz. Sericite and sillimanite, in addition to a second small muscovite, penetrate and replace lobate quartz and other earlier minerals. Garnet is late; it displaces muscovite and contains muscovite as well as quartz as inclusions. Zircon, graphite, magnetite, and apatite are late, since they are distributed along fracture and are embedded in other minerals.

In summary, the probably paragenesis follows from earliest to latest: small quartz and muscovite, biotite, feldspar, lobate quartz, muscovite, sericite, sillimanite, garnet, zircon, apatite, graphite, and magnetite.

Garnetiferous Mica Schist

Distribution and Character

The garnetiferous mica schist is most widespread along what has been previously mapped as the Wedowee formation. It forms a fairly well-defined unit, but in places merges imperceptibly with muscovite schist, and in other places with feldspathic schist. It, however, shows abrupt transition into phyllite and locally into muscovite schist, particularly in the western part of the district near feldspathic bodies.

The schist is grayish to reddish or purplish, but its color, as well as its fissility, depends in large part on the kinds and abundance of the locally predominating minerals. The most abundant minerals are biotite, quartz, and muscovite. Grayish colors prevail where biotite and garnet are subordinate; deep reddish and purplish colors where the garnet is more abundant. Muscovite gives much of the rock a pearly luster, darker, however, than that of the muscovite schist. The schistose structure is well developed, but is not so perfect where the rock is highly garnetiferous. The bending of mica around garnet crystals is conspicuous, thus prominently disrupting the cleavage. The rock is fine- to coarse-grained. In addition to the more abundant minerals that have been named, the schist also contains minor amounts of sodic

plagioclase, sillimanite, sericite, kyanite, zircon, graphite, and magnetite.

Mineral Relations

Mineral relationships are not unlike those in the muscovite schist. The biotite occurs both as irregular inclusions within muscovite and quartz and as larger grains penetrated by them. Muscovite also occurs as small grains included within large crystals of muscovite and as small grains that project into the large crystals. The muscovite inclusions are accompanied by rounded grains of quartz, and the penetrating grains, by sericite and sillimanite. Sodic plagioclase, where present, may hold inclusions of muscovite and quartz. Most of these minerals, including mosaics of granular quartz, are penetrated by and held as inclusions within grains and seams of lobate quartz. Some of this lobate quartz holds needles of sillimanite, but it, as well as the muscovite, biotite, and feldspar, are also penetrated by irregular sillimanite-sericite aggregates. The garnet, which in places comprises as much as 10 to 15 per cent of the rock, forms well-shaped crystals measuring up to 5 millimeters in diameter, most of which hold abundant inclusions of quartz, muscovite, and biotite. The crystals are also surrounded by zones or mantles of mica. The graphite, which is sparsely disseminated as unoriented crystals, lies along borders and embeds grains of mica, quartz, and feldspar as well as the aggregates of sillimanite and sericite. The kyanite occurs only in association with sillimanite or sericite, as subhedral crystals, which are irregularly penetrated by the sillimanite. Much of the kyanite contains remnant inclusions of muscovite. Also, as in the muscovite schist, the magnetite and zircon are distributed along boundaries, cleavages, and fractures of other minerals.

Paragenesis

The same clear indication of mineral succession that presents itself in the muscovite schist is apparent in the garnetiferous schist. Again, the early quartz and muscovite is included by nearly all minerals. Biotite and feldspar, more abundant in the garnetiferous schist, show their relations more clearly. Biotite, in larger grains, is penetrated more widely, and feldspar also is more obviously embedded by later minerals and shows inclusions more clearly. The ever-present lobate quartz embays all preceeding minerals.

Kyanite is the only mineral present not observed in the muscovite schist. Its close associations and relations with sericite-sillimanite indicate that it formed just ahead of the sillimanite, largely by replacing the muscovite. Zircon, graphite, and magnetite show identical relationships, although the graphite almost disappears in much of the garnetiferous rock.

The paragenic sequence in order of formation is identical to that of the muscovite schist; small quartz and muscovite, biotite, muscovite, feldspar, lobate quartz, muscovite, kyanite, sericite, sillimanite, garnet, zircon, apatite, graphite, and magnetite.

Phyllite

Distribution and Character

The phyllitic rocks form a considerable part of what has been mapped previously as the Wedowee formation. They lie within an ill-defined strip roughly parallel to, and extending brokenly along, the full length of the tin belt. The rocks are best developed near quartz veins, pegmatites, and contacts of granitic bodies.

The phyllite is fine grained, thinly laminated, and shows a prominent pearly bluish sheen on fresh cleavage surfaces, or a bluish-yellow mottling on weathered surfaces. It is composed largely of fine-grained quartz, biotite, and muscovite, none of which is easily distinguished without the microscope. Subordinate minerals include chloritoid, graphite, zircon, tourmaline, magnetite, and locally, kyanite. The graphite, tourmaline, and magnetite become abundant only near pegmatitic or quartz veins and virtually disappear in the rock some distance away. The bluish sheen is apparently given by the microscopic grains of graphite. Some of the phyllite has so much finely crystalline graphite that the rock is dark gray to black and soils the fingers. Such highly graphitic rock (locally designated as "amorphous graphite") generally occurs against pegmatites and quartz veins, although some layers have been found well out in the phyllite and even in the schist. Such layers can rarely be traced for more than fifty feet.

The phyllite is highly laminated and in thin section shows numerous seams of mica and quartz, all showing more or less parallel orientation. In the more quartzose rock the foliation is

less distinct and the rock loses its prominent laminated structure. The highly micaceous phyllite may be finely crenulated.

Mineral Relations

The minerals have much the same relationships as those of the muscovite and garnetiferous schists. Most of the muscovite grains are comparatively large and fairly well oriented. They penetrate small quartz aggregates and many contain small biotite remnants. Most of this muscovite, in turn, is penetrated by lobes of quartz and some of it is even held as corroded inclusions within the quartz. Smaller rudely parallel muscovite grains lie between grains of lobate quartz and also in fractures in the quartz. Here and there a larger grain may lie entirely athwart the lineation.

The biotite, which is partly or entirely bleached, not uncommonly encloses small rounded quartz grains. It is everywhere filled with a fine opaque dust, probably magnetite and graphite. The biotite may be present as remnants enclosed in quartz and muscovite.

The quartz, as granular aggregates, forms poorly-defined, interrupted layers. These aggregates are penetrated by, and remnants are included in, biotite, muscovite, and large grains of lobate quartz. The lobate quartz partly destroys the foliations, though the grains are, for the most part, elongated in the same direction as the other minerals.

Most of the tourmaline is black and occurs as small euhedral crystals, which are particularly abundant in the highly micaceous, crenulated phyllite adjacent to pegmatites and quartz veins. Some of the tourmaline contains inclusions of quartz muscovite, and biotite, but in general, the schistosity curves around rather than continues through the crystals. Euhedral crystals of graphite, typically lath-like, are closely associated with the black tourmaline, but occur in large part as impregnations in fractures in muscovite. Other grains of graphite, with magnetite, embed the tourmaline conspicuously. Finely disseminated grains of graphite occur throughout most of the rock. Large irregular grains of magnetite are closely associated with the black tourmaline and graphite. They are distributed in fractures in the muscovite and also embed quartz, kyanite, and black tourmaline. As quartz increases in abundance,

tourmaline, flake graphite, and magnetite decrease and virtually disappear.

Lithia tourmaline occurs as an accessory in quartzose phyllite. Its euhedral crystals show no definite orientation, but cut across the schistosity and penetrate large quartz grains. Kyanite appears only near granitic bodies. It tends to assume euhedral form, usually in masses of small muscovite grains, and may penetrate irregularly into and surround lobate quartz and muscovite. Chloritoid is irregularly distributed through the phyllite. It forms euhedral crystals in and cuts aggregates of muscovite. This mineral is also one of those cut by quartz. Small zircon grains occur in cracks and between grains of all minerals except magnetite, graphite, and tourmaline.

Paragenesis

The minerals of the phyllite show a fairly well-defined order of formation, determined largely by successive replacements. This sequence is much the same as in the muscovite and garnetiferous schists. The major difference exists in the presence or absence of certain minerals; otherwise the succession is the same. Small early quartz lacks its accompanying muscovite and the absence of feldspar and sericite-sillimanite aggregates is noted, but both black and lithia tourmaline appear as additional accessories.

The probable paragenetic sequence is: early quartz, biotite, muscovite, chloritoid, late quartz, muscovite, kyanite, zircon, tourmaline, graphite, and magnetite.

Hornblende Schist and Gneiss

Distribution and Character

Hornblende schist and gneiss are found within the Ashland series principally in the western part of the district. These rocks occur commonly as tabular bodies 2 to 10 feet or, exceptionally, 100 feet thick, which are apparently concordant with the bedding. They are extensive and may be traced for miles, but individual bodies may show considerable variation in thickness. Contacts with bordering schists are generally sharp.

The rock may be greenish-black, composed entirely of hornblende, and possessed of a decided schistose structure, or it may be composed of bands of feldspar and hornblende and distinguished by a prominent gneissic structure. In either case the rock is fine- to medium-grained.

Mineral Relations

In addition to the hornblende and feldspar, thin sections show olivine, hypersthene, sphene, zoisite, zircon, and apatite. The texture is markedly different from that of all other rocks of the district, being more typically granitoid. Minerals do not penetrate, nor do they appear as inclusions, as they do in the other schistose rocks. They possess the relations of minerals that have crystallized from magma.

Some variety of hornblende usually makes up 50 per cent or more of the rock. This is generally edenite or pargasite but in some rocks there is also a dark hornblende. Feldspar (andesine-labradorite) makes up as much as 40 per cent of some of the gneissic rocks. It shows extensive alteration to zoisite. The hypersthene is as abundant as the hornblende in some of the rock, but in places it is absent altogether. The various amphiboles and pyroxenes are also extensively altered to zoisite. Sphene is an abundant accessory and zircon a minor accessory.

These schists and gneisses are apparently altered basic igneous rocks that have intruded the Ashland as sills. They are probably the same rocks, which in Clay County, are described as altered igneous sills by Brown (1925, p. 214).

Feldspathic Schists

Distribution and Character

The feldspathic schists are transitional rocks, merging with the granitic rocks on the one hand and with the mica schists on the other. They are for the most part distributed about the margins of granitic bodies, but although they are largely restricted to the tin belt, they may occur in other parts of the district. The feldspathic schists are more resistant to weathering and erosion than the other schistose rocks.

The schist cleaves readily along closely-spaced parallel surfaces and shows glistening mica crystals on cleavage surfaces. Its schistosity is not so well defined, however, as that of the muscovite schist, apparently because the presence of considerable feldspar tends to make the rock more gneissoid. Bands of fine-grained feldspar-quartz aggregates alternating with those of mica are easily distinguishable. The rock is light to dark gray in color, the darkness depending on the proportion of biotite.

The leading minerals include untwinned sodic plagioclase or potash feldspar, quartz, biotite and muscovite. The minor minerals are clinozoisite, epidote, zircon, apatite, and a little hematite. The feldspar and quartz together compose about 70 per cent of the rock, the mica about 25 per cent, and the remainder about 5 per cent. The feldspar is more abundant than any other mineral, normally making up 30 to 40 per cent of the rock.

Mineral Relations

Most of the minerals, except the feldspar and those that are minor, have a fairly pronounced elongation parallel to the foliation, but the muscovite and quartz do not show the orientation quite so well as do the biotite grains. As the feldspar does not show the elongation of the other leading minerals, it tends to give the rock a decided granitoid appearance. Were it not for the abundant feldspar grains, the rock would have precisely the same structural, textural, and mineralogical characteristics as the mica schist.

The relations of the minerals in the feldspathic schist are in no way different from the relations of the minerals in the muscovite schist. Mosaics of granular quartz and small grains of biotite are penetrated by and included as remnant grains within large crystals of muscovite. These mosaics as well as the large crystals of muscovite are in turn penetrated and contained as remnant inclusions within the feldspar grains. All these are in turn cut and embayed and, in part, engulfed in large grains of lobate quartz, which make up from 10 to 20 per cent of the rock. The minor minerals such as apatite, zoisite, zircon, and magnetite commonly lie between the grains of the more abundant minerals. Apatite is more plentiful than in the non-feldspathic rocks.

Paragenesis

The mineral relationships again indicate a succession similar to that in the muscovite and garnetiferous schists and phyllite. The sequence begins with quartz and biotite, which are then succeeded by muscovite, feldspar, quartz, zoisite, zircon, apatite, and magnetite. The difference between the feldspathic schist and the muscovite schist is in the abundance of feldspar rather than in any dissimilarity in paragenesis.

Quartz-diorite Gneiss

Distribution and Character

The quartz-diorite gneiss merges imperceptibly with feldspathic schist. The gneiss also shows internal changes with transition in places to a coarse-grained rock resembling pegmatite. These gradational changes are well shown north and west of Manning's Store and also just east of Rockford. The bodies of gneiss are commonly irregular, particularly those of large size, but some form lens-like masses 50 to 300 feet long, conformable with the enclosing muscovite or garnetiferous schist, but separated from them by a narrow intervening zone of feldspathic schist.

The rock usually has the appearance of a medium-grained light-gray, gneissoid granitic rock in which feldspar, quartz, muscovite, and biotite may be readily recognized. Where the proportions of feldspar and quartz increase and the grains enlarge in size, the rock loses much of its biotite and its gneissoid character and becomes almost pegmatitic. Where such changes have taken place, considerable amounts of microcline appear in the rock, which otherwise contains sodic plagioclase as the only feldspar. Clinzoisite is an abundant accessory; zircon is present in sparse amounts.

Mineral Relations

The lineated structure is indicated in thin-section by irregular layers or bands composed of aggregates of elongated quartz grains, feldspar, and muscovite. These minerals appear to be interpenetrated and are marked by irregular borders. Many small rounded quartz grains, however, are scattered through the rock and are included in, as well as embayed by, all other minerals (Pl. II, fig. 1).

The individual mineral relationships are in all other ways very similar to those in the feldspathic schist. Muscovite is widely included and cut by quartz and feldspar. Biotite, where present, occurs as inclusions in muscovite, quartz, and feldspar. Lobate quartz penetrates deeply into all minerals present, except the accessories. Clinozoisite is a fairly abundant accessory and occurs principally at contacts of muscovite and feldspar, or feldspar and quartz. Zircon is rare and is confined to fractures in quartz and feldspar.

The minerals in the "pegmatitic facies" have the same relations as in the remainder of the rock. The added microcline has caused little change except in the composition of the rock. It embays the sodic oligoclase and also holds numerous inclusions of it as well as of quartz, and muscovite. Where the sodic oligoclase is embayed by microcline it is commonly penetrated by small rods of vermicular-like quartz.

Paragenesis

The mineral sequence of the quartz-diorite gneiss and the feldspathic schists are essentially identical. The order of formation is: quartz, biotite, muscovite, sodic oligoclase, microcline, clinozoisite, quartz, and zircon.

Granitic Rock

Distribution and Character

The granitic rock designated by Gault (1942) as the Pinckneyville quartz-diorite complex occurs near the east border of the tin-bearing belt (Pl. I). The main Pinckneyville body which is approximately 30 to 40 miles long and 6 to 10 miles wide, is bordered by muscovite and garnetiferous schist on its southeast as well as on its northwest sides. The body, as outlined, is not wholly granitic but, as shown by Gault, contains much included schist. Its contact with the schist is gradational, not sharp. This gradation is particularly pronounced along the tin belt, the rock showing transition to feldspathic schist, to muscovite schist, and to phyllite. Some masses of the granitic rock are also contained in the tin belt as well as elsewhere throughout the area of schistose rocks.

Gault (1942) has subdivided the "complex" into hornblende-

gneiss, quartz-diorite gneiss, granodiorite gneiss, and granite. The granitic rock near and within the tin belt is principally quartz-diorite. The rock in and near the tin belt apparently contains somewhat less feldspar and biotite and more quartz than in the main body. Excellent detailed descriptions of the Pinckneyville rocks have been given by Gault (1942).

Mineral Relations

All the rock of the Pinckneyville complex shows a rude gneissic banding, and mineral relationships not unlike those of the feldspathic schists. Specimens collected half a mile west of Alexander City show inclusions of small rounded quartz grains within crystals of muscovite, biotite, and plagioclase; also lobate grains of quartz, which, however, are not so abundant as those in the schist. The muscovite penetrates as well as holds inclusions of the biotite and quartz and, in turn, is penetrated and contained as remnant inclusions within the sodic plagioclase. All these are penetrated by grains of lobate quartz.

Paragenesis

A detailed succession of minerals in the Pinckneyville complex is outside the scope of this paper. A general sequence has been set up, however, which is fairly well indicated. The succession appears to be early quartz, biotite, muscovite, feldspar, later quartz, and accessories.

Aplite

Aplites are scattered throughout the district. Most of them are less than two inches thick, but a few measure up to fourteen inches. Some cut, but most of them lie along the schistosity. They also cut Pinckneyville granite, but age relationships with pegmatites were not ascertained. The dikes are deeply weathered and the only recognizable minerals are fine-grained quartz and some muscovite, both embedded in kaolin. The weathered rock has a pale cream color.

Pegmatites

The pegmatites in the district are of two distinct types—dikes

and irregular replacement bodies. The dikes are associated with the granitic rocks of the area; the replacements are confined to the Ashland schists and are most strikingly developed along the tin belt.

Dikes

Most of the dikes are in the Pinckneyville granite in the eastern part of the district, but a few are scattered elsewhere. The dikes apparently occupy fractures in the granitic rock. Walls are sharp; the bodies are straight and very constant in thickness. Some are no more than an inch and none is more than two feet thick. A few may be traced for a hundred yards or more without showing any change in thickness and without disclosing either end. The dikes trend in the same direction as the regional schistosity, N. 10°-30°. The dip is steeply east or west.

The dike rock is light colored but has a minor white and grayish mottling. The grain size is variable but no minerals exceed 3 inches in longest dimension. The rock is composed largely of oligoclase, albite, orthoclase, microcline, quartz, and muscovite, but also has a little garnet, allanite, tourmaline, and biotite. These dikes contain no tin.

Replacement Bodies

General Features

The replacement pegmatites include all those that contain tin as well as many that do not. These are grouped largely along a narrow zone that extends in a north-northeasterly direction across the district, parallel to the regional schistosity (Pl. I). It is the concentration of the tin-bearing pegmatites along this zone that has prompted the use of the term "tin belt". There are countless numbers of pegmatites along this belt ranging from mere stringers to bodies as much as 100 feet wide and 3000 feet long. In places the pegmatites are so closely spaced that they cannot be mapped as separate bodies; in one place they have been mapped collectively as a body several hundred feet wide and more than 1½ miles long. Many of the bodies are arranged en echelon.

Unlike the pegmatite dikes, these bodies are not uniformly

thick but tend to pinch and swell and otherwise may be quite irregular as to shape. Most of them are more or less lenticular, but some may pinch or swell so abruptly that parts of them may be essentially chimney-like. Contacts with the bordering schist are not clearly defined, but in most places the pegmatites shade more or less imperceptibly into the bordering country rock. The contact may or may not parallel the schistosity, though, in general, the bodies tend to conform with it or cross it at a very low angle. The contact may actually be most irregular. In some places the bordering schist has been very much contorted, but more generally there is no evidence that the pegmatite has had any physical effect on the surrounding schist.

Descriptive Features

The replacement pegmatites are composed of a light-colored rock, which shows considerable variation in the size of the mineral grains. Much of the rock is similar to a coarse-grained granite with few grains more than one inch long, but some is much more coarsely grained, and has minerals which measure 2 to 4 inches and even 12 inches long. The size of the grains apparently has little relation to the size of the deposit, for the smallest body may be as coarse-grained as some of the largest. There may be much variation in grain size in any body and change from fine to coarse grain may be fairly abrupt. Graphic texture shows in only a few places.

Most of the pegmatites show a rude banding represented by concentration of certain minerals along walls or along the interior of the mass. Some of these bands resemble streaks of even veins, which appear as though they cut through the body of the pegmatite. Locally these forms are pipe-like. Some of the rude banding reflects a more or less distinct zonal arrangement of the minerals. Pegmatite may also show a more or less pronounced gneissic banding, particularly near the walls where its rock merges with that of the schist, but this structure may also extend throughout the entire body.

Mineralogy

Most of the pegmatites are composed of variable amounts of microcline, albite, quartz, and muscovite, along with much lesser

amounts of biotite, topaz, beryl, cassiterite, apatite, fluorite, corundum, tourmaline, epidote, garnet, and pyrite. The proportion of the more abundant minerals, such as the feldspar, quartz, and muscovite, change little along a given pegmatite but may vary considerably from one pegmatite to another. Except for scattered pockets, the other minerals are but scantily represented.

The microcline, which is one of the most distinctive minerals of the pegmatites, is abundant in some but present in small amounts in others. It occurs in both small and large grains, some as much as 4 inches long. Much of that megascopically visible is flesh-colored but some is distinctly reddish. It shows a nearly constant association with quartz, in places forming graphic-like intergrowth. It also is invariably accompanied by a small amount of muscovite. The smaller grains appear as granular aggregates with equally small grains of quartz and muscovite much as in "granite", but the larger grains, many of which tend to assume euhedral forms, penetrate these granular quartz-muscovite aggregates and hold remnants of these as inclusions. These larger grains also embay and hold remnant inclusions of fractured sodic plagioclase and penetrate and "crowd aside" large crystals of muscovite. Some of the microcline is veined by albite (Pl. II, fig. 2).

Albite is found abundantly in all but the quartzose pegmatites, commonly in bands or seams of variable width more or less intimately associated with quartz and muscovite. Its grains, which are subhedral to anhedral, are white and, therefore, contrast sharply with the microcline. The grains are smaller than those of microcline and are less resistant to weathering. Like the microcline, the albite holds inclusions of quartz and muscovite, (Pl. II, fig. 3), but it also veins and holds remnants of microcline and embays and corrodes the larger crystals of muscovite. Where it penetrates, it assumes a somewhat lobate form, except where it veins microcline.

The quartz occurs in variable amounts in all the pegmatites but generally as one of the most abundant minerals. It is ordinarily more abundant in the smaller than in the larger pegmatites and some bodies are so quartzose that they might be more aptly classed as quartz veins. The quartz has a granular appearance and may range up to $\frac{1}{4}$ inch in diameter in the larger bodies. It is colorless to gray, locally bluish in some of the coarse-grained

pegmatites near bodies of granitic rock. Some of the quartz is intimately associated with feldspar, in part as "graphic granite", but its most notable association is with muscovite in prominent irregular bands or pipes near pegmatitic centers. These bands are composed of fine- to coarse-grained quartz and muscovite and have much the appearance and relations of greisen, as an alteration of the pegmatitic rock. The quartz in the pegmatite does not all have the same relation. Some occurs as small grains with aggregates of quartz and muscovite, which also may be engulfed as remnant inclusions within larger grains of muscovite, microcline, and albite, as well as within large grains of a lobate quartz. The lobate quartz may also embay and hold remnants of the muscovite, albite, microcline, and biotite. (The above relations are shown on Plate II, figure 3). There apparently is more than one generation of quartz with lobate habit for some of the lobes are veined, also by quartz.

Muscovite is very abundant in all pegmatites and is also present in some quartz veins. Its size as well as its abundance within any body is extremely variable. It ranges from microscopic crystals to those 12 inches in diameter. It is normally clear but may possess a very light greenish tinge. Muscovite has been mined from at least two localities near the tin belt, one in Sec. 10, T 21 N., R 18 E., and the other in Sec. 15, T 22 N., R 18 E. Both of these mines have been abandoned (Pl. I). Muscovite from the latter locality formed the largest books of the district. These books were close to the walls of the pegmatite, as well as in the center, arranged in bands with quartz and feldspar. Muscovite in other pegmatites is similarly distributed. Exceptionally, muscovite forms small books with quartz. It is usually not abundant with microcline and does not occur in "graphic granite".

In addition to the small grains in the quartz-feldspar aggregates there are the larger clear crystals which cut directly across and penetrate the aggregates. These, along with lobate quartz, also fill cracks in broken cassiterite. This is well illustrated on Plate II, figure 6.

Biotite is rarely seen in hand specimen and was not found in thin-section.

Topaz is abundant only in border zones of small pegmatites

with most of it impregnating the schist. It is closely associated with cassiterite. It also penetrates deeply into the muscovite grains and holds remnants of them as ghost-like inclusions as shown in Plate II, figure 5.

Beryl is present in scant amounts, mostly along the marginal zones of the pegmatite and in the bordering schist. It commonly has remnants of muscovite and quartz, also small liquid inclusions.

Apatite occurs widely and is locally an abundant accessory. It may occur as tiny inclusions in lobate quartz, as inclusions in garnet, as small to large irregular grains admixed with grains of other minerals, and as large grains penetrating and holding inclusions of quartz and albite.

Fluorite is rare; but appears here and there as tiny rounded grains in quartz.

Corundum was noted as euhedral crystals in only one thin section of pegmatite. There crystals contained inclusions of quartz, but relations to other minerals could not be established.

Tourmaline occurs sporadically in pockets, usually with quartz and albite. It is particularly abundant south and east of Rockford where it is contained in highly quartzose pegmatites. Crystals are shiny black and range from microscopic to $1\frac{1}{2}$ inches in diameter. The crystals are invariably fractured and the fractures filled with quartz.

Epidote is seen in thin section as irregular ragged grains within albite usually penetrating from grain borders, but it may also be distributed along fractures. Here and there it appears as inclusions within garnet.

The garnet is irregularly distributed through many of the pegmatites, generally as crystals of microscopic size. It has an euhedral form and cuts across and apparently pushes other minerals, particularly muscovite, to one side. In addition to epidote, it also holds inclusions of quartz, albite, muscovite, and other minerals.

Pyrite was seen in a pegmatite at the Number 7 mine of the Coosa Cassiterite Corporation. It is disseminated within coarse quartzose rock.

Cassiterite is discussed in detail in the latter part of the report that deals directly with the tin deposits. It occurs as broken subhedral crystals which commonly contain small inclusions of quartz and muscovite. The grains tend to embay and cut the larger muscovite crystals. In one place a grain of cassiterite has penetrated completely through a crystal of muscovite. Fractures in the cassiterite are filled with quartz and small grains of muscovite as shown in Plate II, figure 6.

Paragenesis

Most of the pegmatites show a fairly constant mineral succession. Small grains of quartz, biotite, muscovite, and microcline, seem to have been inherited from the schist. They have been extensively penetrated and replaced successively by the large crystals of muscovite, and by microcline, albite, and lobate quartz. Most of these features are clearly illustrated on Plate II, figure 2. Later than the microcline, albite, and lobate quartz are epidote, corundum, garnet, apatite, fluorite, tourmaline, topaz, cassiterite, beryl, muscovite, quartz, and pyrite. The precise order of some of these later minerals is not certain, but the cassiterite and the minerals that follow are probably in the correct order.

Contacts and Zonal Arrangement

Small replacement pegmatitic bodies 2 to 4 feet wide are generally not much banded and their contact zone is no wider than 5 or 6 inches. These contacts are gradational usually showing no intercalation of schist and pegmatite.

Larger replacement pegmatites commonly show a definite zonal arrangement both within the body and at the contact. This zoning gives the aspect of layers. Those which make up the contact zone are thin, being 1 to 4 or 6 inches wide. A typical arrangement of these layers from schist to the pegmatite would be: schist, quartz, tourmaline schist, amorphous graphite, quartz, granate, pegmatite or quartz, albite, muscovite, amorphous graphite, quartz, and tourmaline schist. This arrangement does

not represent a constant sequence, but only illustrates the heterogeneity of the rock types which make up the border zones. Many bands are sharp, but some are gradational, true especially of those composed of pegmatite and granite.

Within the main pegmatite the bands are as much as 1 to 2 feet wide and are composed of notably different mineral assemblages as compared with those in the border zone. The widest bands are those composed of quartz, feldspar, and muscovite. These also are the most common and may compose the entire mass of the non-banded pegmatites. They usually occur nearest the borders and may be as much as 8 to 10 feet wide. Zones of quartz and muscovite may lie within the pegmatite, having only a rough parallelism to the walls and no definite location within the body. Weathering tends to accentuate the differences between these mineral groupings. Granitic bands weather most rapidly, whereas the quartz-muscovite bands are extremely resistant. The latter may be the only part of the pegmatite visible to the prospector. It is, incidentally, the only part of the pegmatite that carries visible cassiterite.

Quartz Veins

The quartz veins may be divided into three groups, each of which possesses distinctive characteristics. In the first group the veins occur as thin lenses and pod-shaped masses composed of clear to milky massive quartz, except where local fracturing has granulated the quartz and given it a distinct sugary appearance. They pinch and swell abruptly and usually cannot be traced more than 30 to 40 feet. Their width varies from knife-edge to 6 feet. These are the tin-bearing veins and many grade into pegmatite. Some of these bodies contain tourmaline, which is generally arranged in streaks, particularly along contacts. Platy hexagonal ilmenite crystals have been found in fractures in some of them. These veins are scattered along the entire tin belt with almost constant regularity. The larger ones are shown on Plate I.

In the second group the veins form rudely elliptical bodies as much as 50 feet across, composed of milky barren quartz in which small amounts of tantalite-columbite and beryl have been found. These bodies are clustered around the northern periphery of the Rockford stock. (See Plate I).

In the third group the quartz occurs as stringers rather than as veins. These stringers, few of which are more than one inch thick, are distributed throughout the Ashland schists comprising perhaps one-tenth the total volume of rock. Their occurrence appears identical to the veins in Clay County, reported by Brown (1935) where observations across 60 feet of schist, which on casual inspection showed virtually no quartz, actually disclosed 40 veins totaling 53 inches in thickness, or 5 per cent of the total section. Twenty-five inches was contained in three veins and the others were less than one inch thick. As pointed out by Brown, the feldspathic and quartzose materials "permeate the very fabric of the schist, constituting 20 to 30 per cent of the rock in sections where igneous influence in the hand specimen is unsuspected".

Structure and Regional Trend

Regional schistosity, striking N. 15° - 30° E. and dipping southward about 65 degrees, is the outstanding structural feature. The bedding, where apparent, almost always parallels the schistosity, but may dip less steeply.

Lineation of pegmatites, quartz veins, and gneissic bodies also parallels the schistosity and is quite prominent. The pegmatites and quartz veins may show an echelon arrangement especially in the northeast, the offsets usually being less than 100 feet. The alignment of the Rockford stock, with the large pegmatite mass at the junction of Hatchet and Socapatoy Creeks, together with the gneiss to the north of Manning's Store, is also noteworthy.

Predominant northeast regional lineation and southeasterly dip, with suggestions of northwest trends, indicates stresses applied from the southeast with major relief upwards and some rotation.

Variations in regional trend, although slight, are conspicuous in the vicinity of the Rockford stock. Zones of pegmatite and pegmatitic quartz veins striking N. 40° E. intersect the regionally trending pegmatite belt to the northwest and to the west of Rockford. Near each of these two intersections occur massive quartz plugs. North and northeast of Rockford the schistosity locally strikes N. 80° E. and a small discontinuous pegmatite strikes N. 40° W. A line extended to the southeast about one mile along this direction intersects the tin-bearing pegmatites just south of the

Coosa Cassiterite mine site. Two hundred yards west of the pegmatite lies a pipe-like quartz mass. The local variations roughly outline the borders of the Rockford stock. It may be that the emplacement of the stock caused these local departures from the regional trend or, more probably, the stock is older and locally affected later regional stresses.

Small-scale folding of both bedding and schistosity is common. Microscopic to three-inch drag folds are found adjacent to pegmatites and quartz veins, whereas commonly 6-to 24-inch crenulations and corrugations occur, apparently unrelated to any local control. Single or double folds occur here and there, but never exceed 10 feet in amplitude.

Evidence of larger scale folding is plentiful. There is a major reversal of regional dip about 25 miles to the east of Dadeville, Alabama. Occasional small angular differences in bedding and schistosity indicates folding of some importance. Brown (1925) has reported that clear evidence exists for definite closed folds in Clay County. Farther to the northeast extensive folding has been well established.

Small high-angle, normal or reverse, strike faults are common. The local cross-trends east and west of Rockford are suggestive of fracturing. Drag folds in schist adjacent to pegmatites and quartz veins usually show shearing movements. Extensive micro-brecciation within pegmatite bodies is further evidence of shearing stresses.

One low-angle thrust is exposed along an extensive road cut on highway No. 11 in sec. 30, T. 24 N., R. 18 E. This fault branches, showing two sliding-surface traces with well developed drag folds for a distance of 100 feet or more. The fault zones are kaolinized.

Extensive folding, perhaps with overturning to the northwest, was accompanied by fault adjustments and thorough saturation by solutions. Schistosity was developed parallel to easiest relief, which, in many cases, was also parallel to the bedding. Rotational movements caused small shearing stresses in a northwest direction.

All fractures and lines of weakness were pathways for solutions, which healed breaks by depositing minerals in the openings



Figure 2. Small high-angle fault in schist. More resistant layers are quartz veins. White vein to left is pegmatite. Sec. 24, T. 22 N., R. 18 E., $\frac{1}{2}$ mile southeast of Rockford.

and adding substances to the bordering wall rocks. Locally, where cross fracture occurred, and in large shear zones, the solutions were more active and larger replacement bodies were formed.

Continued movements are reflected in the folded and drag-folded schistosity, the micro-brecciation in pegmatites and quartz veins, and small faults displacing the schistosity.

Topographic Develolpment

The upland surface that characterizes the area has been dissected to a stage of late youth and early maturity. Dissection has been greatly influenced by the geologic structure. A pattern of parallel and elongated hills, ridges, and valleys is directly controlled by the underlying structural trends and by the differences in rock resistance to erosion. Prominent northeast-southwest ridges controlled by siliceous rocks are prominent in the western part of the region. Ridges controlled by quartz veins, pegmatitic, and granitoid rocks are common in the east. All the tin deposits northeast of Manning's Store are along one narrow prominent ridge. The large pegmatitic mass shown near the center of Plate I, also, is outlined by a ridge more than 100 feet high and 500 feet wide.

Lowly elevated areas, such as the region around Rockford, are underlain by massive granitoid rock and are locally called "flat rock" localities. The schist has been removed from the underlying gently-domed granite in these places.

The drainage, which is controlled almost entirely by the structure, is deflected by these granitic rocks. Excellent examples of this are seen around Rockford and around the small hill on which the Coosa Cassiterite Mine is located. In both places the streams have a radial pattern which outward changes to annular. Control of Socapatoy and Hatchet Creeks near their junction, by the above mentioned pegmatite mass, is also evident.

Granitization and Pegmatitization- Conclusion

The fact that the various schists and gneissoid rocks show such a striking mineralogical, textural, and structural resemblance to the granitic rocks of the region and such a marked transition from one to another, suggests that they may be the products of intense and widespread granitization. The schists differ from the granitic gneisses only in their lack of feldspar, but near granitic bodies feldspar makes an appearance and tends to modify the schistosity and make the rock more gneissoid. Still closer to the "granite" the schist becomes so rich in feldspar that it actually is changed to gneiss. This change is gradational. The gneiss thus produced is almost identical with the "granite" and actually merges with it. These changes largely involve the addition of feldspar and quartz and a number of the so-called accessory minerals. These additions have been largely at the expense of previously existing minerals; in other words, the early country rock has been extensively replaced by micas, feldspars, and quartz; the feldspar being more restricted in its distribution than the other minerals, forming bodies of "granite" and of "granite gneiss".

Such widespread transformations must have been produced under the influence of igneous emanations from some deeply seated magmatic source, apparently the same source that supplied the Pickneyville granite. The emanations obviously introduced potash, soda, and silica on a very extensive scale. These permeating emanations apparently accompanied regional deformation and were localized and guided principally by structural zones of weakness. Locally, where the rock was more pervious, the solutions were able

to penetrate more copiously and arrive at higher temperatures; there feldspar was formed abundantly. Farther away from these zones of particular structural weakness the solutions permeated more slowly and arrived at lower temperatures, which were within the stability range of muscovite and quartz. Thus granitic rock facies were formed along the more pervious channelways and schistose rock was formed elsewhere.

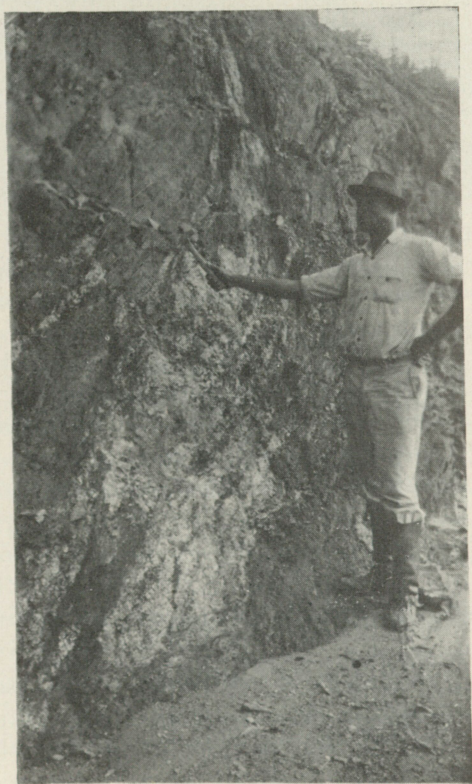


Figure 3. Replacement pegmatite in muscovite schist showing irregular shape and contacts. Sec. 34, T. 24 N., R. 19 E.



Figure 4. Pegmatite in muscovite schist two miles east of Rockford on Highway No. 22.

The transformations did not end with the widescale granitization, but was continued locally along certain zones of recurrent structural weakness by a closely succeeding pegmatitic stage. These later emanations carried boron, fluorine, tin, beryllium, and other elements, which had not been present in the earlier fluids, as well as potash, silica, and soda. These emanations penetrated the rock of these zones and added the minerals that have given rise to the pegmatites. Thus the pegmatites have grown by replacement of schistose country rock.

TIN DEPOSITS

History and Production

C. U. Shepard discovered cassiterite nuggets in 1880 on the property of Judge J. S. Bentley near Rockford (Adams, 1930). Little prospecting was done until 1932, and then only after cassiterite had been found on the Rudisill property near Manning's Store.

In 1934 samples were taken and analyses made from the three known deposits on the Rudisill property by Ellsworth (1934). The results of this work were not promising.

Prospecting continued between 1934 and 1939. In 1939 Bowles (1939) took "grab" samples and made analyses from the known localities, which then were ten in number. He suggested that extensive prospecting was justified; activity in the district increased.

In September, 1940, three corporations were formed to undertake the development and mining of tin deposits. These included the American Tin and Mining Company, Inc.; The Coosa Cassiterite Corporation; and The Atlantic Engineering Company.

The Coosa Cassiterite Corporation erected a 25 ton roll mill and began operation August 1, 1941. Before the mill closed on January 15, 1942, five tons of concentrates were sent to the Vulcan Dettinning Company at Sewaren, N. J. The reasons for closing operations are not clear. Presumably, the lean ore and low price of tin combined to make the operations unprofitable.

The American Tin and Mining Company prospected deposits discovered in Sec. 28, T. 23 N., R. 19 E., but the work was soon abandoned.

In 1943 Mineral Concentrates, Incorporated, was formed. This new corporation recently started operations at the old Coosa Cassiterite mine with the assistance of an R. F. C. development loan.

Classification

The tin deposits of Coosa County may be classed as replacement pegmatites, quartz veins, and placers. Fully 90 per cent of

the tin found has been in replacement pegmatites and practically all the rest in quartz veins. The tin is not necessarily limited to the veins and pegmatites, for in some places it impregnates the immediate bordering schist. Placer "deposits" show only traces of tin.

Tin-bearing Pegmatites

Distribution and Character

All the known tin-bearing pegmatites are shown on Plate I. It may be noted that these pegmatites occur in two general belts; a short one west and northwest of Rockford, and a longer one extending from Coosa Cassiterite mine to a point about five miles northeast of Manning's Store.

The known pegmatites bearing tin are small to average size only, that is, most of them measure 10 to 20 feet long and 2 to 6 feet wide. They are simply replacement pegmatites locally enriched with cassiterite.

Mineralogy and Distribution of the Tin

Cassiterite (SnO_2) is the only tin mineral in the district. The crystals are black to dark mahogany brown in color, but the powdered mineral is almost white, though possessing a definite brown-purplish cast. The grains are usually less than $\frac{1}{4}$ inch long, but crystals over 2 inches long have been reported. They are irregular to subhedral in shape, and are extensively broken and veined. The crystals and grains are disseminated through most parts of the pegmatites; but ore shoots, although they are known in feldspathic bands, are largely confined to quartz-muscovite zones. The disseminated grains are smaller than the crystals within quartz-muscovite bands and commonly become so minute that "pepper tin", a local term, is very appropriate.

Where tin occurs in small pegmatites or in shoots adjacent to schist, it may also be distributed in the adjacent country rock inter-leaved with oriented grains of muscovite and quartz. Topaz also may be abundant, cutting and including ghost-like remnants of muscovite as shown on Plate II, figure 4. It forms a topaz rock.

Because of the few visible exposures, the distribution of the cassiterite is not well known. The ore shoots are very discontinuous, swelling or disappearing within a few feet. They seem to favor the hanging wall, especially where the dip is low, and apparently become richer where there is a flattening of the dip. This was noted particularly in Mine No. I on the Coosa Cassiterite property. In some places, however, there is a suggestion that the cassiterite is more abundant in the narrow parts of the pegmatite but relations are not wholly clear. The cassiterite apparently favors the more quartzose pegmatites.

Size and Grade

The ore shoots are small, extremely irregular, and pockety. Many pockets, 6 to 8 inches thick and several feet apart, are connected by thin blade-like stringers of cassiterite. These shoots are very difficult to trace and in places disappear completely only to appear farther on. One very rich pocket of ore was bottomed only 20 or 30 feet below the surface. Outcrops with cassiterite crystals are almost all in quartz-muscovite bodies ranging from $\frac{1}{2}$ to 2 feet or 2 to 3 feet wide and from 8 to 10 feet long. As pointed out elsewhere, the tin is contained in pegmatites of relatively small size. At the Coosa mine the pegmatites are about 20 to 40 feet long and 3 to 10 feet wide. These have not been bottomed at depths of 50 to 80 feet. Generally, smaller outcroppings "lens out" completely a few feet below the surface, but some of these bodies are largely concealed by overburden, and are much more extensive below the surface.

The content of cassiterite in these deposits is extremely variable. This is because of the irregular character of the pegmatite itself and the inconsistency of the cassiterite shoots.

Sampling of deposits is almost useless unless extensive trenching is done so that a representative composite sample of the rock to be mined can be tested. Labor for trenching was not available in the summer of 1942. Bowles (1939) took "grab" samples from 10 localities and had them analyzed, but the returns gave only the percentage of tin at the point from which the samples were taken. Ellsworth (1934) took two samples from the tin-bearing pegmatites known in 1934. One was a 10-pound sample from the richest looking pegmatite about $\frac{1}{2}$ mile southwest of Manning's Store. This

had 3.6 per cent metallic tin. Another sample of pegmatite and schist taken 30 feet below a tin shoot showed only a trace of tin.

The overall grade of the tin ore can best be calculated from the amount of tin recovered at the Coosa Cassiterite Mill. Much of the ore had been sorted by hand, and therefore, was somewhat richer than that blasted from the deposits, but losses in milling somewhat compensated for the hand concentration and the recovery is probably a fair measure of the average grade of the ore. This ore was removed from three pegmatites. Figures supplied by Mr. Charles A. Dean (1942) of the Coosa Cassiterite Mine are here reproduced by his permission. During the six months of operation approximately 10,000 pounds of rather pure cassiterite concentrate were recovered from 888 tons of rock. Thus the ore carried approximately 0.56 per cent of SnO_2 by weight.

Tin-bearing Veins

Distribution and Character

Tin-bearing quartz veins are known in two localities. One is 200 yards east of Manning's Store, and the other at the American Tin and Mining Co. prospect in Sec. 28, T. 23 N., R. 19 E. The veins are irregular, but have a lenticular habit, and range from a few inches to six feet in thickness. They belong to the quartz veins that have been placed in group I.

Mineralogy and Distribution of Tin

Cassiterite in quartz veins generally has a reddish-brown color but in places may be black. Much of it is somewhat stained by limonitic oxides. The cassiterite occurs in irregular vein-like masses up to 3 or 4 inches long in the sugary granulated portions of the quartz, usually near the edges of the veins, but in some places in the fractured rock well toward the center of the veins. Smaller irregular grains occur also in the sugary quartz.

Adjacent muscovite schist for distances of one to two inches is not so uncommonly impregnated with small cassiterite grains. Locally these grains may make up 50 per cent of the rock. Granitic rock near the tin veins may also carry a trace of tin.

Size and Grade

The more or less disseminated or vein-like masses bordering the quartz-schist contacts are highly concentrated and represent very rich ore, probably as much as 10 to 20 per cent SnO_2 . These are very localized, however, and generally are of small extent along the contact. The cassiterite in the center of quartz veins is ordinarily sparsely scattered, but some seams $1/8$ to $1/4$ inches wide have been found in float.

A representative sample of the tin-bearing quartz vein east of Manning's Store was taken by Ellsworth (1934). This sample showed 0.4 per cent metallic tin. Figures for the veins at the American Tin Mine prospects are not available, although picked specimens probably approximate 10 to 20 per cent cassiterite.

Zonal Distribution

The pegmatites, quartz veins, and feldspathized schists show somewhat of a zonal distribution. The bodies are most numerous and reach their largest size near the margins of granitoid rocks, then become smaller and more widely scattered out therefrom. At greater distances the feldspathic schists and pegmatites disappear altogether and the quartz continues on only as innumerable tiny stringers with here and there veins a foot wide.

The cassiterite and tourmaline also show an interesting distribution. The tourmaline is very abundant in the quartz veins east and south of Rockford, in schist adjacent to pegmatite bodies, and in a few of the pegmatites. It is particularly abundant northeast of the northernmost occurrence of tin, more so than at any place between there and Rockford. In both localities the tourmaline is closely adjacent to granitoid rocks. The cassiterite, which is confined largely to the area between these two localities, rarely is associated with tourmaline, even though at Manning's Store it is very near granitic rock. Gevers (1942) points out a somewhat similar relationship in African pegmatites. He finds that tourmaline and cassiterite rarely occur together and that the tourmaline is much nearer the granite than is the cassiterite. This, he suggests, may reflect a thermal control, the tourmaline deposited at a higher temperature and therefore closer to the granite than the cassiterite. Whether this is the case in Coosa County is not

definitely known but the mutual exclusiveness of cassiterite and tourmaline is evident.

Origin and Localization

The replacement pegmatites and quartz veins as pointed out elsewhere, have a definite structural control. They occur along lineated zones of weakness in which the rocks have been greatly sheared.

The localization of the cassiterite within the pegmatites and quartz veins also shows a definite relation to fractures. In the quartz veins the cassiterite is definitely distributed along fractures in the sheared quartz and also along cleavage planes of the adjacent schist. Although there may be very minute grains of cassiterite in the feldspathic portions of the pegmatites, most of the ore is invariably within vein-like zones of quartz and muscovite that cut through the feldspathic rock well toward the interior of the mass. These vein-like tin-bearing zones are the youngest of several special "mineralized" or "greisenized" (Johannsen, 1932, p. 6) zones that occur as layers or bands within the pegmatites, and is the youngest of the layers or bands in them. Repeated fracturing apparently opened channel-ways for the circulation of solutions, which introduced new materials that were added as new minerals, in part replacing those formed earlier. This, as shown by several generations of the same mineral, was done in successive waves of mineralization.

Cassiterite was apparently one of the earlier minerals formed in the quartz-muscovite bands, since it has been broken and then veined by the quartz and muscovite. There has been, however, more than one stage of quartz and not less than two stages of muscovite deposition represented in these quartz-muscovite masses. All the cassiterite may not have been deposited at the same time, but the evidence is inconclusive.

Economic Possibilities

The tin deposits of Alabama lie within small replacement pegmatites. These bodies are very irregular in shape and size as are the ore shoots within them. This irregularity in shape and size, the small size, and the low tenor of the ore makes mining

an extremely uncertain undertaking. With domestic tin a necessity, however, a small amount can be recovered from the district.

Geothermal Data

The following results were obtained for the rocks sent to Dr. N. B. Keevil of the University of Toronto Physics Department. The samples were taken at approximately two mile intervals from east to west across the Pinckneyville complex and the bordering schists.

Rock	Activity Alphas/mg/hr.	Heat Production cals/gm/Mil. years
Granite	2.50	5.73
Granite	1.25	2.81
Granite	0.39	.88
Pegmatite (6 inch)	0.78	1.75
Pegmatite	2.63	5.92
Granite	0.92	2.07
Granite	1.33	2.99
Granite	0.98	2.20
Pegmatite	0.91	2.05
Granite	0.49	1.08
Coarse pegmatite	1.60	3.60
Pegmatite	4.06	9.13
Granite	2.58	6.03
Pegmatite	1.50	3.38
Quartz vein (8 inch)	0.08	0.18
Granite	0.83	1.87
Pegmatite	0.50	1.12
Pegmatite	0.80	1.80
Pegmatite	0.67	1.51
Mica Schist	1.99	4.48
Phyllitic schist	1.66	3.74
Phyllitic schist	1.89	4.26
Phyllitic schist (oxidized)....	2.77	6.23
Mica schist	2.72	6.12

"These data cannot be used to calculate age. However, it is often found that intrusives of different ages have different radio-activities and this may be used as indirect criterion of age similar to heavy mineral studies." (Keevil, 1943)

MINES AND PROSPECTS

Tin is known to occur in 28 separate points along the tin belt, not all of it, however, in place. Some is known only in blocks of float, the sources of which have not been found. Attempts have been made to mine several of the deposits. These have been designated as mines; the others on which only a little development work has been done are given as prospects. For location of the mines and prospects refer to Plate I.

Mines

The deposits so far worked are at the No. 1 mine, No. 2 mine, and No. 7 mine, all held by lease by the Coosa Cassiterite Corporation. These mines are in Sec. 8, T. 23 N., R. 19 E. Other pegmatites have been prospected, but have been abandoned. The more important deposits are shown on the geologic map of the property (fig. 5).

No. 1 Mine

This mine, the first developed, has a 130-foot inclined shaft directed S. 25° W. (fig. 6). The shaft has an angle of 34° for the first 90 feet and then becomes practically horizontal for the remaining distance. Cross-cuts have been driven 8 feet northwest and 15 feet southeast at a point 20 feet from the bottom of the incline.

The workings are almost entirely within a pegmatite, which at the surface strikes N. 25° E. and dips 80° S.E., being conformable with the enclosing schist. At depth the steep southeast dip apparently becomes vertical and then changes to northwest. The contacts of the pegmatite with the schist is only partly exposed. At the surface the immediate wall rock is amorphous graphite, which forms a 3- to 4-inch band cut by thin quartz stringers. Along the shaft the bordering rock is granite, which forms a layer 3 to 12 inches wide. This granite shows transition to schist, but in places quartz stringers separate the granite from the schist.

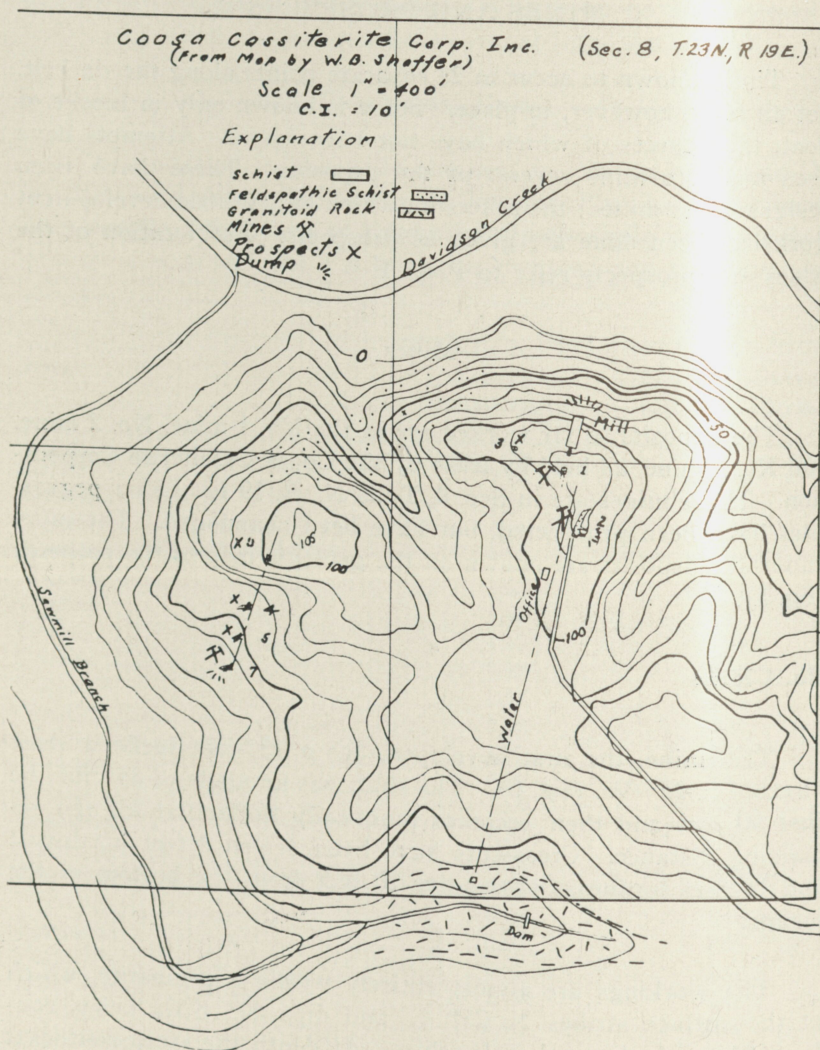


Figure 5. Geologic map of Coosa Cassiterite Corporation lease in Sec. 8, T. 23 N., R. 19 E.



Figure 6. No. 1 Mine portal. Note the schistosity.

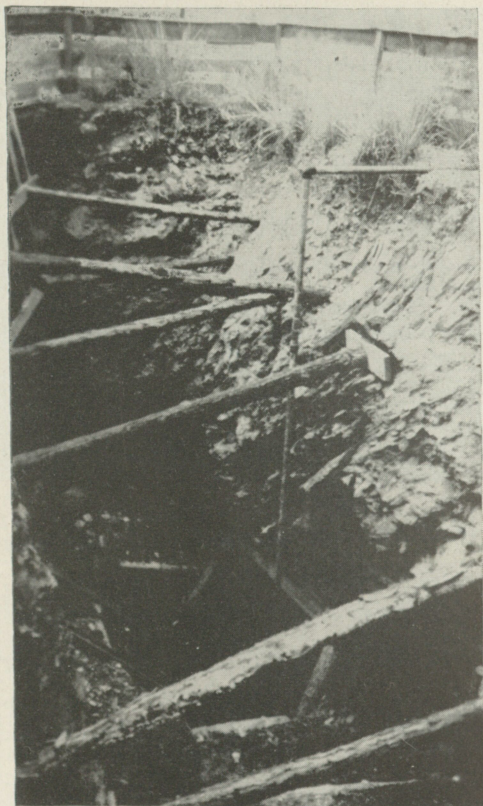


Figure 7. South end of pit at No. 2 mine. The collar of the inclined, branching shaft is in the lower part of the picture.

The mine was opened on a 2- to 3-foot quartz-muscovite shoot, which carries cassiterite crystals measuring up to $1/8$ inch in diameter. The shoot forms but a small part of the pegmatite mass, which in its entirety is 8 to 10 feet wide. The quartz-muscovite shoot pinches and swells, but never exceeds its surface width by more than one foot. At the bottom of the incline one of two quartz-muscovite bodies is $2\frac{1}{2}$ feet thick. This lies at about the center of the pegmatite. It now has but one or two visible cassiterite grains, but in the part that was mined the tin mineral was distributed sporadically in pockets and as scattered grains (pepper tin). These scattered grains occurred also in parts of the adjacent feldspathic rock. The second body is near the hanging wall.

It is 3 feet long and $\frac{1}{2}$ foot thick and contains from 3 to 4 per cent cassiterite. This seems to be one of a series of small interrupted hanging-wall shoots.

The pegmatite as well as the component quartz-muscovite bodies appear to become larger with increasing depth, whereas the cassiterite becomes less abundant. Consequently the richest ore is in the narrow part of the pegmatite, within 30 to 40 feet of the surface.

No. 2 Mine

The No. 2 mine is on a pegmatite about 200 feet southwest of No. 1. The development comprises a cut 80 feet long driven S. 20° W. and a shaft inclined 50° and driven N. 80° W. has been sunk near the south end of the cut for a distance of 40 feet measured along the incline (fig. 7). At a point 10 feet below the collar of this shaft another incline has been driven S. 15° E. at an angle of 30° with the horizontal for a distance of 65 feet.

The pegmatite strikes N. 35° E. and dips steeply northwest, but flattens with depth. It is largely conformable with the schistosity. It is bordered in part by schist, by granite, and by amorphous graphite. This pegmatite may merge at depth with the one at the No. 1 mine.

The 40-foot incline was started on a small body of cassiterite contained in a quartz-muscovite shoot. At a depth of 10 feet, however, the shoot was lost and the remainder of the incline exposed only barren feldspathic pegmatite. The other incline cut the quartz-muscovite shoot within several feet and continued on it to the bottom. The shoot is fairly irregular and in places pinches out. It seems to follow the hanging wall. The cassiterite is irregularly distributed in the quartz-muscovite rock, much of it in small pockets, some of which have carried 3 to 8 per cent SnO_2 . Only a few cassiterite grains are now visible.

No. 7 Mine

This is the latest development on the property and is reputed to have opened the richest body of ore. The workings include an open cut, which slopes downward at an angle of 40° until it reaches

a depth of 25 feet. From there on the work has been continued as an inclined shaft. When examined in 1942, the shaft was filled with water, but the total length along the incline is reported to be 110 feet.

The pegmatite appears to strike about N. 50° E. and dips 51° S.E. That which has not been mined is deeply weathered and relations to the wall rock are obscure. The country rock is a crenulated, dark-blue phyllite.

The dump shows much quartz-muscovite "greisen", which contains more or less pyrite and large grains of apatite. Some of the "greisen" also carries as much as 3 to 5 per cent cassiterite.

Prospects

Prospect No. 5

This prospect is on the Coosa Cassiterite Corporation lease and is known locally as No. 5 mine. It is located 200 feet northeast of No. 7 mine in Sec. 8, T. 23 N., R. 19 E. (fig. 5). The work comprises a trench about 40 feet long and 4 feet deep across a highly micaceous pegmatite. The pegmatite, which is about 3 feet thick, strikes N. 45° E. and dips 70° S.E. It shows a rather sharp transition into the apparently conformable enclosing schist.

Some sparsely disseminated, flat, cassiterite crystals have been found in the most highly micaceous part of the pegmatite. Tantalite has been reported.

Prospect No. 3

This prospect is in the SE $\frac{1}{4}$ of Sec. 28, T. 23 N., R. 19 E. It has been explored by the American Tin and Mining Company. The development has uncovered a quartz lens 100 feet long and 5 feet wide, exposing it to a depth of 10 to 15 feet. This lens strikes N. 15° E. and dips 60° S.E. The quartz is massive, colorless to milky white, and is contained between walls of crenulated muscovite schist. Some cassiterite is distributed along fractures in the quartz, particularly along the footwall margin of the lens, but most of it is in rich pockets and is disseminated as grains in the bordering schist. Little of the cassiterite remains unmined.

Prospect No. 4

This prospect is 1000 yards east-northeast of prospect No. 3. No work has been done, but the deposit, a quartz vein, is fairly well exposed in the outcrop. The vein is about 6 inches thick and is composed of milky, in part "sugary" quartz, cut by veinlets of cassiterite and muscovite measuring up to 1/8 inch wide. Some float is strewn over the surface.

Prospect No. 6

This prospect is in the SW $\frac{1}{4}$ of sec. 31, T 24 N, R 20 E. It is known locally as "the Doctor's Place" and is the one that Bowles (1939) designated as his locality 1.

Some tin has been found in one of many narrow pegmatite seams in crenulated phyllite, but the most notable occurrence is in blocks of float, which have not been traced to their original source. Most of the pegmatitic seams are composed of quartz, muscovite and feldspar and measure from an inch to as much as 2 feet thick. The one with cassiterite is 2 to 4 inches thick and is composed mostly of fine-grained oriented muscovite with a little quartz. There are a few quartz veins from 2 to 3 feet wide, but these are not known to be tin-bearing.

Some of the float contains exceptional amounts of cassiterite. Blocks 1 to 2 feet thick are strewn conspicuously over an area 200 feet long and 100 feet wide. These blocks are composed of coarse-grained quartz and muscovite and contain as much as 2 to 3 per cent cassiterite. Assays made by Bowles reveal as much as 2.8 per cent metallic tin. Many of these blocks have been used for terracing the land for farm use. Three blocks 2 to 4 inches thick composed of fine-grained quartz and muscovite were found in the area. These resemble the fine-grained tin-bearing muscovite and quartz rock that is found in place and also carry tiny cassiterite crystals.

Prospect No. 8

This prospect is in the SW $\frac{1}{4}$ of Sec. 31, T 24 N, R 20 E., 450 feet south-southwest of Hatchet Springs Church. Some flat grains of cassiterite are embedded in lens-like bodies of muscovite, which

become 4 to 6 inches wide. The muscovite shows parallel orientation, which gives the bodies a schistose appearance. The bodies, however, have been formed by replacement and are not bands of original schist. They apparently represent a peculiar kind of pegmatite formation.

Prospect No. 9

This prospect is 100 yards south-southwest of prospect No. 8. The only disclosure is a rounded boulder exposed as float in an open field. The boulder is composed of quartz, but contains some coarse muscovite and a few small crystals of cassiterite.

Prospect No. 10

This prospect is in the NW $\frac{1}{4}$ of Sec. 6, T 23 N, R 20 E. The development comprises a pit about 5 feet deep. In it is exposed a feldspathic pegmatite about 3 feet wide that strikes N. 30° E. and dips 45° SE. This body pinches out within 10 feet. Some tourmaline crystals 1/8 inch long are disseminated through parts of the pegmatite. Cassiterite was observed only in thin section.

Prospect No. 11

This prospect is in the SE $\frac{1}{4}$ of Sec. 1, T 23 N, R 19 E. Only a block of float is exposed. This block is about 2½ feet long, 10 inches wide, and 6 inches high. It is made up in part of sheared milky quartz and in part of quartz-muscovite "greisen". The latter contains cassiterite estimated to comprise about 3 per cent of the whole.

Prospect No. 12

This prospect is in the NW $\frac{1}{4}$ of Sec. 14, T 23 N, R 19 E., 300 yards east of Manning's old store. It was the discovery of tin at this place that rejuvenated prospecting in the district. A detailed description is given by Ellsworth (1934) and will not be repeated here. Six trenches made by Ellsworth uncovered a quartz vein for a distance of 200 feet. This vein pinches and swells abruptly, but averages about 6 feet in width. The borders of the vein are much fractured. Cassiterite is contained along the fractures in the quartz and as impregnations in the bordering schist.

A representative sample taken by Ellsworth contained 0.4 per cent metallic tin. Bowles (1939) reported 0.83 per cent metallic tin in a "grab-sample".

Prospect No. 13

This prospect is located in the SE $\frac{1}{4}$ of Sec. 15, T 23 N, R 19 E., about $\frac{1}{2}$ mile southwest of Manning's Store. This is the one designated as locality 4 in the report made by Bowles in 1939.

The development comprises two shallow trenches, which have uncovered two pegmatites. The pegmatites have been described in detail by Ellsworth (1934). They are 20 feet long and from 1 to 2 feet wide, and are composed of quartz and muscovite with small scattered crystals of cassiterite. Cassiterite is also disseminated in the enclosing schist.

Assays of a 10-pound sample of the richest ore, according to Ellsworth, showed 3.6 per cent tin. A "grab-sample" taken by Bowles contained 0.29 per cent tin.

Prospect No. 14

This prospect is in the SW $\frac{1}{4}$ of Sec. 15, T 23 N, R 19 E. The development comprises a shallow test pit on a very micaceous pegmatite. This pegmatite is the one which Bowles has listed as locality 5. The body is 4 feet wide. It strikes N. 20° E. and dips 70° S.E. Bowles reports 3.3 per cent metallic tin.

Prospect No. 15

This deposit is near the center of the SE $\frac{1}{4}$ of Sec. 22, T 22 N, R 19 E. No work has been done, but the outcrops of two quartz-muscovite lenses about 3 feet long and 8 inches thick are exposed within 10 feet of each other. These lenses show a few small disseminated crystals. The amount of metallic tin is probably less than 0.5 per cent.

Prospect No. 16

This prospect is in the NE $\frac{1}{4}$ of Sec. 8, T 22 N, R 19 E, and is probably the one designated by Bowles (1939) as locality 7.

Only float has been found at this point. This float comprises several small blocks of quartz-muscovite "greisen", which probably contains about 1 per cent cassiterite.

Prospect No. 17

This prospect is in the SE $\frac{1}{4}$ of Sec. 7, T 22 N, R 19 E. The workings comprise a single pit about 3 feet deep in which a coarse-grained quartz-muscovite lens has been uncovered. This lens strikes N. 40° W. and dips steeply southwest. In it are a few small grains of cassiterite concentrated into a more or less well-defined pocket. Altogether the cassiterite may comprise about 0.5 per cent of the body.

Prospect No. 18

This prospect is in the SW $\frac{1}{4}$ of Sec. 8, T 22 N, R 19 E. It covers the outcrop of a quartz-muscovite body about 2 feet wide that may be traced for about 10 feet. In the body are grains of cassiterite in more or less well-defined pockets. The cassiterite may make up as much as 1 per cent of the rock.

Prospect No. 19

This prospect is located in the NE $\frac{1}{4}$ of Sec. 18, T 22 N, R 19 E. The tin is confined to blocks of coarse-grained quartz-muscovite float scattered over the surface of the ground. The float probably contains about 1 per cent cassiterite.

Prospect No. 20

This prospect is in the SE $\frac{1}{4}$ of Sec. 1, T 22 N, R 18 E. Only float has been revealed at this locality, blocks of which have been aligned in a N. 15° E. direction. They are composed of quartz-muscovite "greisen" and a fine-grained sandy, micaceous phase of quartz and muscovite. All the blocks carry some disseminated cassiterite, which probably does not exceed 2 per cent.

Prospect No. 21

This prospect is in the SE $\frac{1}{4}$ of Sec. 1, T 22 N, R 18 E. The outcrop of a lens-shaped quartz-muscovite body is revealed on the

north side of a small creek bed for a distance of about 8 feet. Where exposed, the body is 2 to 3 feet thick. The body strikes about N. 5° E. and dips steeply to the N.E. Some cassiterite is disseminated through the rock, but probably makes up little more than 1 per cent of the mass of the rock.

Prospect No. 22

This prospect is only 200 feet southwest of No. 21. It is on the south side of the same creek bed. The outcrop is visible for a distance of about 4 feet. The body appears to be 2 to 3 feet thick. It contains a little disseminated cassiterite. Some float composed of the same material is scattered 50 to 100 feet to the southwest. Neither the outcrop nor the float contains more than 1 per cent metallic tin.

Prospect No. 23

This prospect is in the NE $\frac{1}{4}$ of Sec. 12, T 22 N, R 18 E, approximately 200 yards southwest of prospect No. 22. The only tin is in a piece of float composed of coarse-grained pegmatite. This block shows that the pegmatite body from which it was derived was at least 8 inches thick. As much as 2 per cent of the float is composed of crystals of cassiterite.

Prospect No. 24

This prospect is in the SW $\frac{1}{4}$ of Sec. 12, T 22 N, R 18 E. Again the presence of tin is revealed in several small pieces of float composed of coarse-grained quartz-muscovite "greisen" and muscovite schist. These float blocks are 4 to 6 inches thick and contain about 1 to 2 per cent cassiterite.

Prospect No. 25

This prospect is in the SE $\frac{1}{4}$ of Sec. 13, T 22 N, R 18 E. Again the visible evidence of tin is in blocks of float, which range up to 8 inches in maximum dimension. The float is represented by quartz-muscovite "greisen", which probably contains up to 3 per cent cassiterite.

Prospect No. 26

This prospect is in the SE $\frac{1}{4}$ of Sec. 13, T 22 N, R 18 E. The development comprises a very shallow pit in which a body of quartz-muscovite "greisen", shaped like an hour-glass and measuring 8 feet long and $1\frac{1}{2}$ feet wide has been uncovered. The body strikes N. 15° E. and dips $60-70^{\circ}$ S.E. It is a local facies of a much broader pegmatitic body that forms a resistant ridge about 100 feet wide and several miles long. Some of the "greisen" facies is very coarse-grained and has crystals of muscovite measuring up to 4 inches and crystals of cassiterite up to $\frac{3}{8}$ inches in diameter. The tin-bearing rock may contain as much as 2 per cent cassiterite.

Prospect No. 27

This prospect is located in the NW $\frac{1}{4}$ of Sec. 23, T 22 N, R 18 E. Again tin is revealed in a block of float, which forms a slab 4 feet long, 3 feet wide, and 8 inches thick. This block is composed of quartz-muscovite "greisen" with small scattered crystals of cassiterite.

Prospect No. 28

This prospect, which is known locally as the "two-bit place" is in the NE $\frac{1}{4}$ of Sec. 22, T 22 N, R 18 E. The workings comprise a trench about 20 feet long and 3 feet deep and a shallow pit about 8 feet in diameter, both on a body of pegmatite. This pegmatite is about 20 feet wide and outcrops along the surface for a distance of 50 to 60 feet. The strike changes from N. 15° E. to N. 5° W. Small scattered bodies of quartz-muscovite "greisen" crop out for a distance of 100 feet or more along the N. 15° E. strike. Cassiterite is visible in the broken rock around the shallow pit. Some very rich ore is reported to have been taken out at this point.

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Plate II

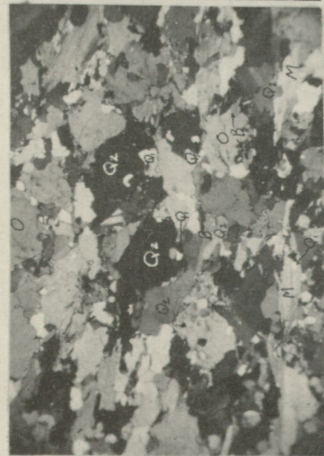


Fig. 1

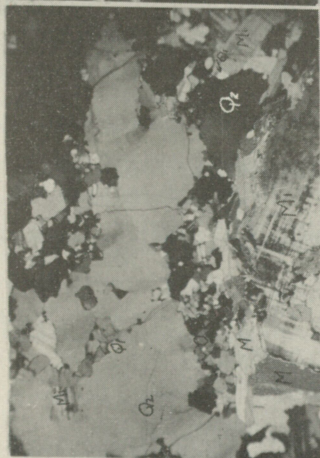


Fig. 2



Fig. 3



Fig. 4

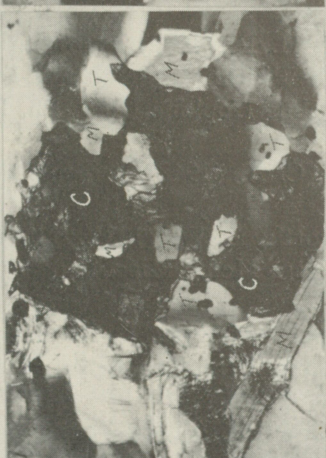


Fig. 5



Fig. 6

Explanation of Plate II

Figure 1. Photomicrograph of Quartz-diorite gneiss.

Inherited schist replaced by quartz, muscovite, sodic oligoclase, and sparse microcline. Early quartz (Q_1) and biotite (B) engulfed and replaced by late muscovite (M), sodic oligoclase (O), and late quartz (Q_2). Late quartz embays muscovite and oligoclase and biotite. Oligoclase impresses and replaces biotite. Crossed nicols x 40.

Figure 2. Photomicrograph of Pegmatite.

Remnant schist, engulfed and replaced by microcline (Mi) and late quartz (Q_2). Oligoclase (O), early quartz (Q_1) and muscovite (M) can be recognized in the residual material. Note the lobate habit of the late quartz and how it penetrates and engulfs all minerals including microcline. Crossed nicols x 40.

Figure 3. Photomicrograph of Pegmatite.

Muscovite (M) impressed by Albite (A) and cut and included by late quartz (Q_2). Albite and late quartz hold inclusions of early quartz (Q_1). Albite penetrated and replaced by late quartz; corrosion. Crossed nicols x 40.

Figure 4. Photomicrograph of Topaz Rock.

Topaz which has replaced muscovite schist. Ghost remnant of muscovite (M) in topaz (T). Crossed nicols x 100.

Figure 5. Photomicrograph of Topaz Rock.

Large crystal of cassiterite (C) with remnants of topaz (T) and muscovite (M). Crossed nicols x 100.

Figure 6. Photomicrograph of Quartz-muscovite "greisen".

Cassiterite crystal (C) impressed against early muscovite (M_1). Late quartz (Q_2) and Muscovite (M_2) in fracture in cassiterite. Crossed nicols x 40.

